LUBRICATION

A Technical Publication Devoted to the Selection and Use of Lubricants

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Roll Grinding

Relation of Lubrication to Precision Finishing

GRINDING and polishing of hardened steel rolls for the rolling of sheet metal products has come to require some of the finest precision work in the grinding industry, coupled with some of the heaviest duty machinery. All this is necessary because many metals and alloys are reduced to the desired thickness by cold rolling processes. This will call for roll surfaces of the utmost perfection to produce sheets, strips, flat wire or foil of the desired quality of finish and uniformly accurate gauge for subsequent manufacturing processes.

In the steel industry the high finish products of the rolling mill include sheets for automobile body and fender stock as well as sheets, strip and flat wire from which are stamped, punched or pressed articles of every description from razor blades of the finest tool steel to metal furniture of bulky proportions.

In turn, gold, silver, nickel and alloys of these metals are rolled into strips having beautiful reflecting surfaces, being used for watch case, vanity case and jewelry manufacture. Aluminum is rolled in sheets and strips from which thousands of different household articles and utensils are drawn, formed, stamped or spun. Tin alloys are rolled into foil of almost incredible thinness—a few ten-thousandths of an inch thick—and used extensively for the packaging of candy, cigarettes, food products, etc.

Few people are familiar with or even aware of the equipment and processes used in making flat, smooth metal from which the things we see and use every day are manufactured.

The Importance of Roll Grinding

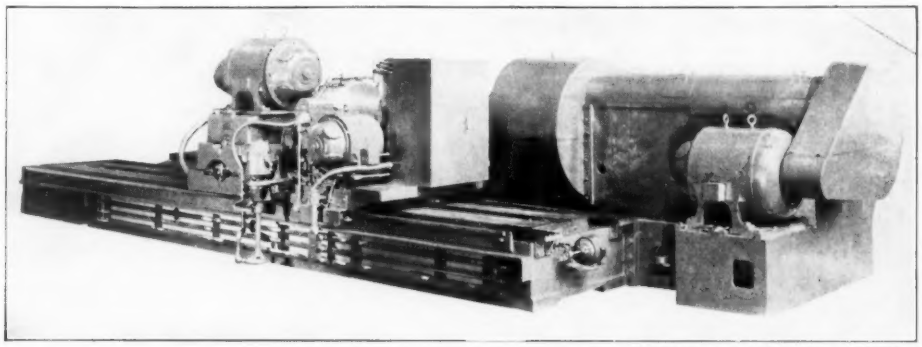
One of the important processes in the rolling mills is the maintenance of the accuracy and finish of the hardened steel rolls. These rolls are all finished by grinding. Some of the smaller rolls such as are used for rolling narrow strip or flat wire, jewelry stock and foil are ground in cylindrical grinding machines specially arranged and equipped. The larger rolls used in the big sheet mills are ground in large powerful and accurate roll grinding machines.

The automotive industry is perhaps entitled to the greater part of the credit for promoting the development of roll grinding machinery, for the majority of the body and fender parts are drawn or pressed from sheet steel. As the automotive industry progressed and increased its consumption of sheet steel, obviously the steel industry had to speed up to meet this demand.

It was no longer practicable to keep roll surfaces in proper condition by re-dressing on lathes, nor could hand work, regardless of care, be as perfect as that performed by a properly designed wheel perfectly centered with respect to the roll surfaces. Reproduction of results is most important; so, when a machine is set to grind to concave, convex, straight or tapered surfaces, it is usually necessary that similar surfaces of like accuracy be developed on more

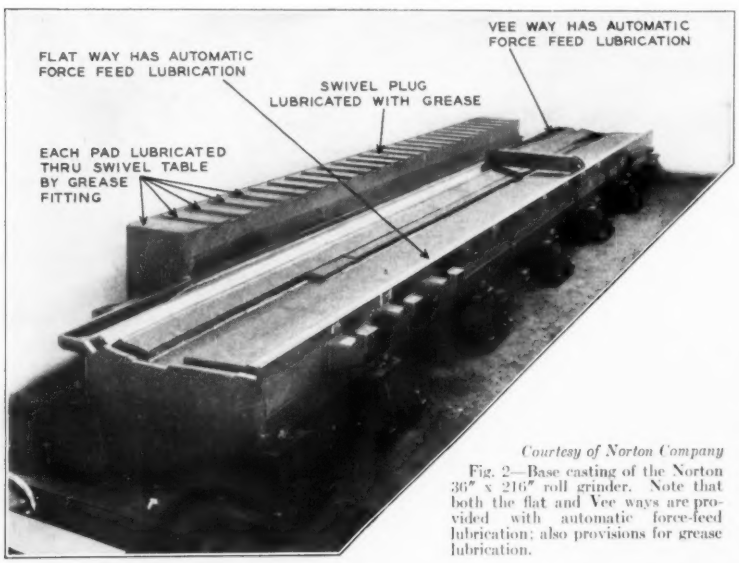
than one roll. These results are the most positively assured by the modern roll grinder because the necessary accuracy is an inherent part of the machine and not a human factor.

So today, manufacturers of metal products are constantly demanding better finish on their steel stock. The steel maker must, therefore, use finer rolls because every mark, scratch or blemish of every kind on the roll surface is reproduced on the surface of the rolled product. The responsibility for these super finishes is passed along to the builder of the grinding machines who, in order to secure the best from his machine, must enlist the cooperation of the grinding wheel maker and the skill of the grinding machine operator.



Courtesy of Farrel-Birmingham Co., Inc.

Fig. 1—Rear view of a Farrel roll grinder showing the motor-driven oil pump mounted at the end of the back bed, which supplies flood lubrication to the inverted Vee ways.


VEE WAY HAS AUTOMATIC FORCE FEED LUBRICATION
FLAT WAY HAS AUTOMATIC FORCE FEED LUBRICATION
SWIVEL PLUG LUBRICATED WITH GREASE
EACH PAD LUBRICATED THRU SWIVEL TABLE BY GREASE FITTING

Courtesy of Norton Company

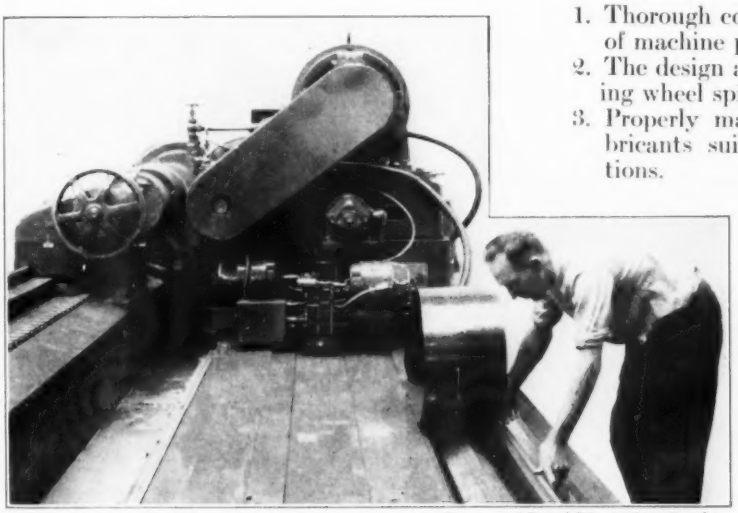
Fig. 2—Base casting of the Norton 36" x 216" roll grinder. Note that both the flat and Vee ways are provided with automatic force-feed lubrication; also provisions for grease lubrication.

Not only must new rolls be ground before they can be put into service but in order to maintain the accuracy and finish required they must be reground many times during their useful life. Wear from pressure and contact with the material rolled soon destroys the finish on the roll surface and the product shows a corresponding change in finish. When the surface of the product is no longer passable the rolls must be removed from the mill and refinished in a roll grinding machine. The length of the period of service of a pair of rolls depends on many factors such as the acceptable finish on the product, the rolling speed, reduction in gauge, hardness of material, etc. A pair of rolls may be used only a few hours or may produce a satisfactory product for several days.

In the modern roll-grinding machine grinding is accomplished by revolving the roll in contact with a revolving grinding wheel and at the same time traversing either the roll past the wheel or the wheel along the roll. Most large roll grinders designed for finishing heavy rolls are of the travelling wheel type, while in most cylindrical grinders arranged for grinding the smaller rolls, the work is traversed. The principle of design involved is that whichever of the two elements is the lighter usually presents the lesser difficulty in traversing and reversing. Comparatively small, light work is easily carried on a traversing table past a fixed grinding wheel station. Large heavy rolls on the other hand are simply revolved and the grinding wheel and its mounting is traversed along the roll.

The bed or base of a roll grinder may be a single casting or two separate parallel sections.

In either case, the front portion normally supports a headstock for revolving the roll, a footstock and a pair of roll journal rests, in other words, the elements of the machine which hold



Courtesy of Farrel-Birmingham Co., Inc.

Fig. 3—View of the Farrel 28" heavy duty roll grinder showing the inverted Vee ways and two motor-driven oil pumps mounted on the end of the carriage base. One pump supplies oil to the spindle bearings and the other to the ways.

and revolve the roll. The rear portion of the bed serves to carry the traversing member on which are mounted the grinding wheel head, the traversing and reversing mechanism, operator's control station, electric motor controls, etc.

All these mechanisms are mounted on a large table or carriage which travels on a pair of ways usually hand scraped to master straight edges to insure that the carriage moves in a perfectly straight line. Since the carriage ways are among the most prominent parts requiring lubrication, their relation to proper functioning of the machine is important.

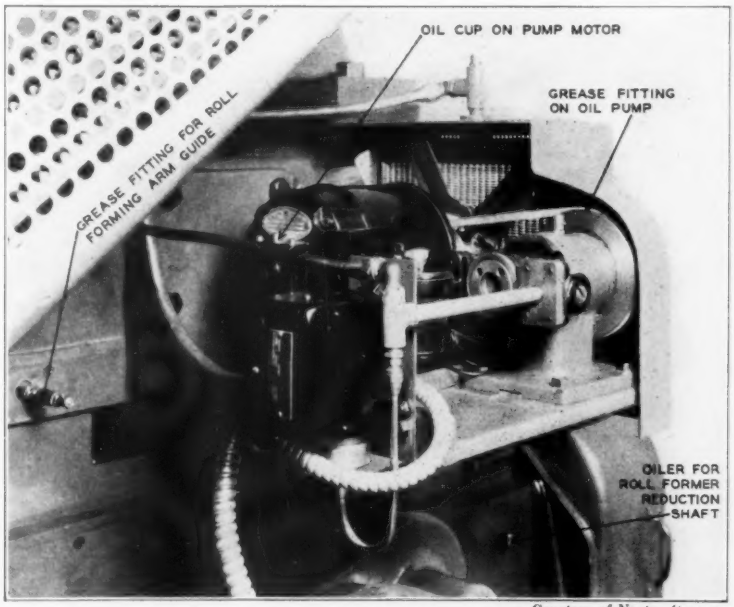
In the traveling wheel type of roll-grinding machine the carriage travels on two wide and well separated parallel ways, one flat and one vee shaped. The wheel head also moves on similar ways at right angles to the table ways. Both of these pairs of ways which support heavy loads are pressure lubricated and adequately guarded from dust, dirt and grit.

How Accuracy of Grinding is Controlled

Dependable operation in the interest of developing uniformly accurate grinding is usually considered as being contingent upon:

1. Thorough coordination in the functioning of machine parts.
2. The design and construction of the grinding wheel spindle and,
3. Properly maintained lubrication, by lubricants suited to the operating conditions.

Coordinated functioning of machine parts is of course dependent upon design, it therefore becomes the responsibility of the designing engineer. In the layout of heavy duty machinery such as the roll grinder, it is especially important to consider lubrication, and the provision for means of circulation or application. Since automatic pressure affords the most positive lubrication it has been widely adopted on such equipment, oil is customarily used for the feed screws, the bearings and gears of the grinder gear-heads, the

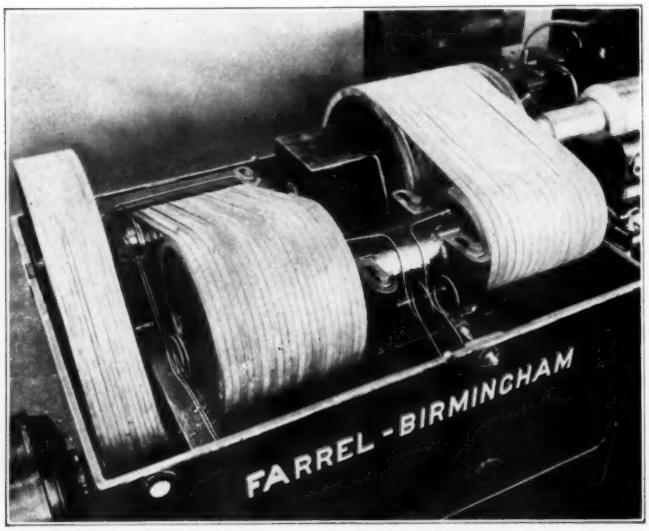

OIL CUP ON PUMP MOTOR
GREASE FITTING ON OIL PUMP
GREASE FITTING FOR ROLL FORMING ARM GUIDE
OILER FOR ROLL FORMER REDUCTION SHAFT

Courtesy of Norton Company

Fig. 4—Wheel spindle oiling arrangement for the Norton 20" and larger grinders, showing mounting, pump and cooling system. Note provisions for periodic oil and grease lubrication on pump motor, oil pump and reduction shaft.

wheel spindle and the Vees or ways on which the carriage rides; grease in turn being applied by pressure gun to the belt-sheave bearings.

The design and construction of the grinding wheel spindle is important because of its influence upon the ultimate accuracy of the machine along with its ability to produce uniformly consistent results. To facilitate this the spindle is usually of large diameter, made from an alloy steel forging which has been heat treated to give it wear-resisting qualities. Extremely large and long bearings are provided which revolve in hard bronze boxes tapered on the outside so as to provide for adjustment. The spindle bearings are very accurately ground and lapped to insure a smooth bearing surface subject to no appreciable initial wear. The boxes are hand scraped to fit the spindle and adjusted to very close clearance for the lubricating oil film. It is obvious that in such a bearing constant and positive circulation of oil must be maintained, as failure of the oil film would permit over-heating and bearing seizure.

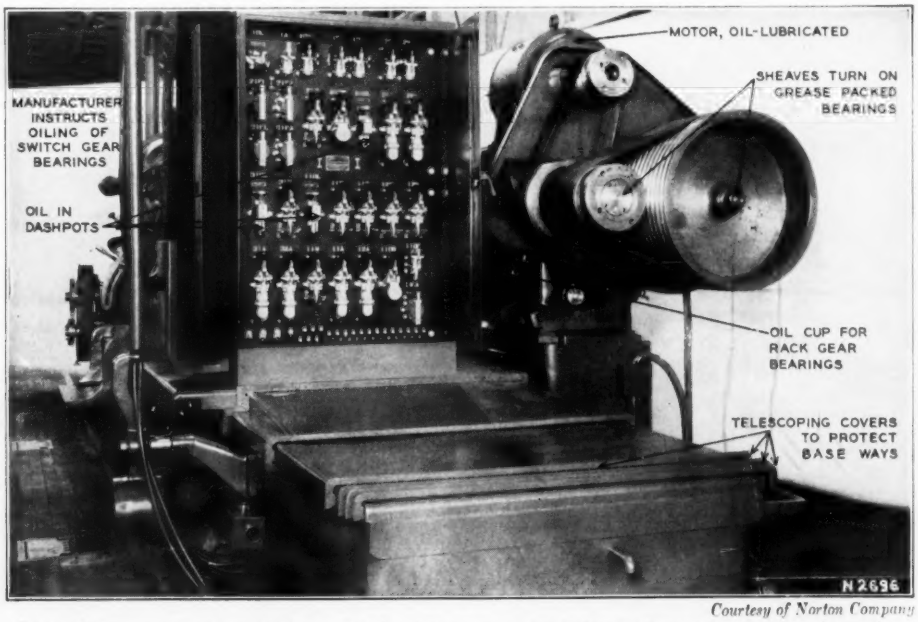


Courtesy of Farrel-Birmingham Co., Inc.

Fig. 5—The anti-friction bearings of the Farrel multiple Vee belt headstock drive are packed in grease. Additional lubricant is supplied by a grease gun through readily accessible Zerk fittings.

For this reason the wheel spindle is lubricated by a separate and independent unit consisting of a motor-driven pump, reservoir, cooling and filtering system and electrical control device so arranged that it is impossible to start the spindle drive motor until the lubricating pump is started and circulation of oil through the spindle bearing is complete.

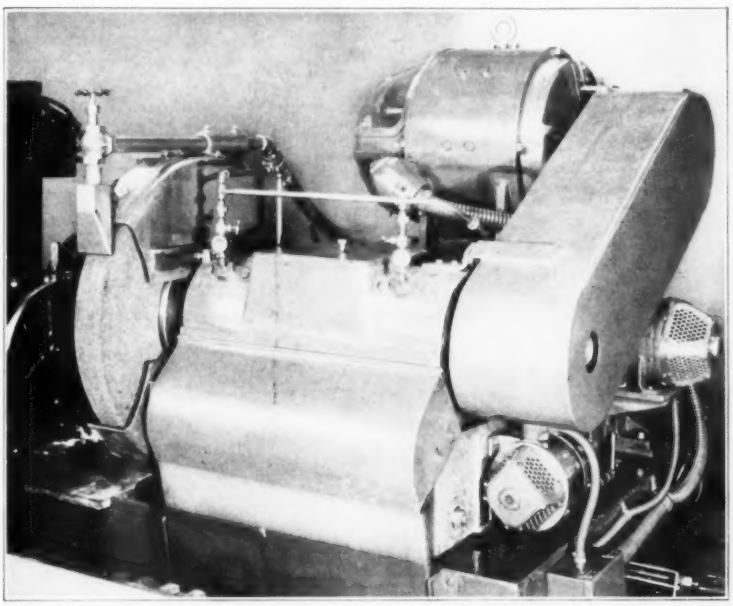
The roll to be ground is revolved by a powerful headstock of the dead center type, driven by a variable speed motor which is usually mounted on the headstock. In some designs the power is transmitted and the motor speed reduced through several multiple "V" belt-drive units. In others the first reductions may be through


MOTOR, OIL-LUBRICATED
SHEAVES TURN ON GREASE PACKED BEARINGS
MANUFACTURER INSTRUCTS OILING OF SWITCH GEAR BEARINGS
OIL IN DASHPOTS
OIL CUP FOR RACK GEAR BEARINGS
TELESCOPING COVERS TO PROTECT BASE WAYS
N2696

Courtesy of Norton Company

Fig. 6—Motor control panel on the Norton 36-inch roll grinder, note also the Vee belt headstock and information pertinent to parts to be lubricated and means provided for same. Of added interest are the telescoping covers to protect the baseways.

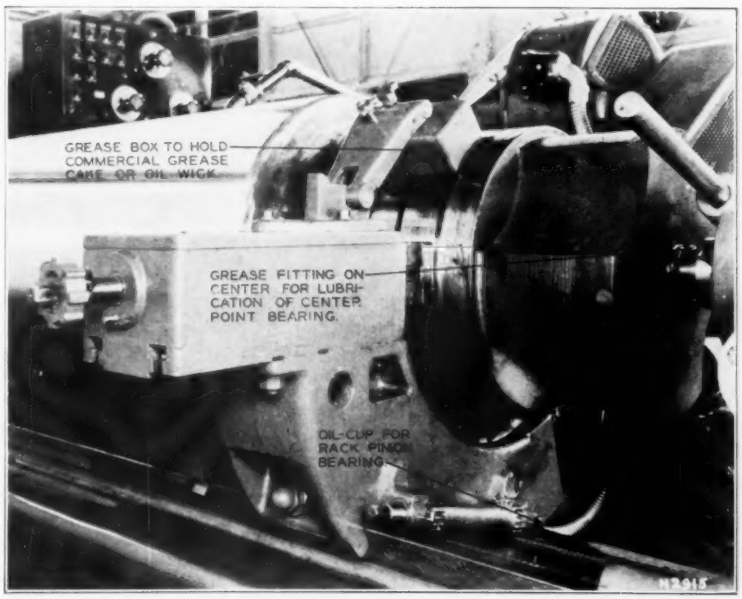
gears and the final drive to the equalizer faceplate through a multiple "V" belt unit. Still others use a combination of belts and silent chain, the latter running in an oil bath. In some machines the headstock and footstock centers are provided with pressure grease gun fittings so that a light semi-plastic grease can be forced to the center points even when heavy rolls are supported on the centers.



Courtesy of Farrel-Birmingham Co., Inc.

Fig. 7—A motor-driven pump mounted on the end of the carriage base of the Farrel heavy duty roll grinder supplies oil under pressure to the spindle bearings. An interlocking control prevents the spindle being operated until after the oil circulation has started.

New rolls are ground on centers so that the journals may be ground and concentricity of centers body and journal bearings assured. Rolls to be reground on the body only are usually revolved in journal bearings or rests attached to the work table of the grinder. These are lubricated by grease applied directly to the bearings as the roll revolves.


GREASE BOX TO HOLD COMMERCIAL GREASE CAKE OR OIL WICK
GREASE FITTING ON CENTER FOR LUBRICATION OF CENTER POINT BEARING.
OIL CUP FOR RACK PINION BEARING

Courtesy of Norton Company

Fig. 8—The two-bearing journal rest with grease box and rack pinion on a Norton travelling wheel type roll grinder. All means provided for lubrication (as shown) enable maintenance of this latter with maximum economy and cleanliness.

Factors Essential to Lubrication

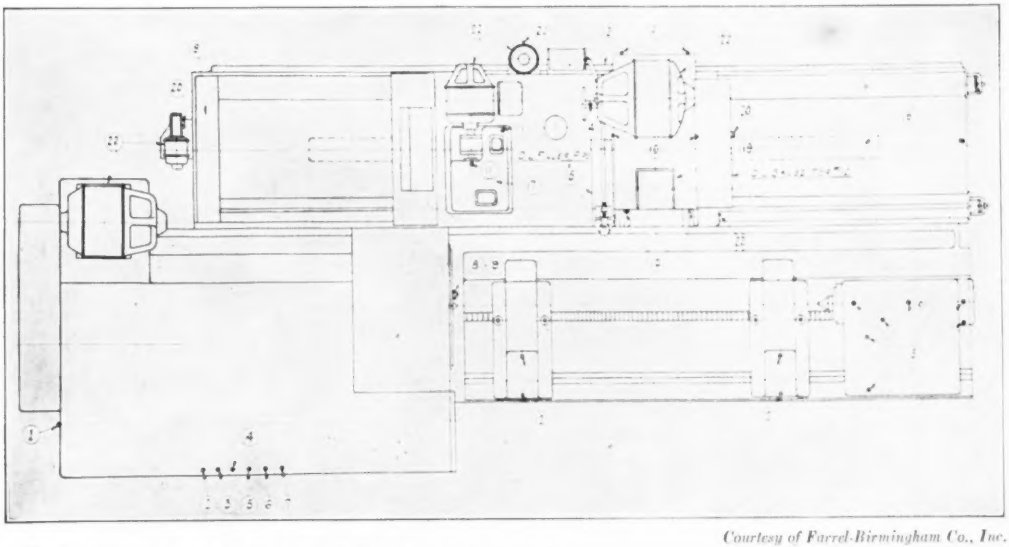
From the viewpoint of the lubricating engineer, lubrication will involve the consideration of physical characteristics of the lubricants to be used, for he will be dealing with existing conditions of construction which are not subject to change.

By reason of the fact that lubrication is largely centralized and almost entirely automatic, lubricants of careful refinement and a high degree of stability are best suited to dependable operation. Normally, spindle bearings will require a straight mineral oil of turbine grade. For such service an oil of around 140 to 200 seconds Saybolt Universal at 100 degrees Fahr., has been found adaptable; and by virtue of its high refinement, markedly resistant to sludge deposition. It is obvious that in the type of lubricating system employed in the modern roll grinder, accumulation of non-lubricating sludge or gummy residues must be prevented, otherwise free circulation of the oil may be reduced.

All this is assured by careful study of the demulsibility characteristics, both when making original selection of the

oil, and later at periodic intervals when the oil is in service. In this regard we will be following the general procedure adopted for the study of steam turbine oils and certain types of steel mill operation where resistance to sludge formation is an important characteristic of the oil.

by application of automatic flood lubrication to insure continual maintenance of an adequate film of oil regardless of temperature fluctuations. Flood lubrication in addition assures of maximum cleanliness by the washing action of the oil which prevents dust, dirt or grit from



Courtesy of Farrel-Birmingham Co., Inc.

Fig. 9—Lubrication chart for a Farrel-Birmingham heavy duty roll grinder.

Fitting Number	*Number of Fittings*	*Type of Fitting*	*Part Lubricated*	*Recommended Lubricant*	*Frequency*
1 & 4	2	Pres. Gun Fitt.	Long Counter Shaft, V-Belt, Pulleys & Clutch		Every 3 Days
8 & 9	2	Pres. Gun Fitt.	Headstock Spindle	Pressure Gun Anti-Friction	Every 3 Mos.
2, 3, 5, 6, 7	5	Pres. Gun Fitt.	Counter Shaft Pillow Blocks	Lubricant—Acid-less	Every 3 Mos.
10	6	Pres. Gun Fitt.	Wheel Head Ways		Every Week
11	2	Oil Pipe	Carriage Drive (Bearings)	Light Filtered Cyl. Oil	Every Week
12	4	Bowen Oilers	Neck Rests	Medium Heavy Machine	Every Week
13	7	Bowen Oilers	Foot Stock	Oil	Every Week
14	1	Oil Cup	Wheel Feed		Every Week
15	1	Oil Pipe	Wheel Feed Worm Wheel		Every 3 Mos.
16		Oil Trough	Carriage Traverse Worm & Rack	Light Filtered Cyl. Oil	Every 3 Mos.
17		Oil Chamber	Carriage Drive		Every 3 Mos.
18		Oil Tank	Carriage Ways	Medium Heavy Machine Oil	Inspect & Fill
				About 1800 Visc. at 100° F.	Every 3 Mos.
19		Oil Chamber in	Carriage Sub-Base for Wheel Spindle	Light Machine Oil about 150 Visc. at 100° F.	Every Month
20	3	Grease Cups	Pumps	Pressure Gun Anti-Friction Lubricant—Acid-less	Every Week
21			Crowning Device	Medium Grease	Every 3 Mos.
22	For Motor Lubrication, See Instruction Plate on Each Motor				

The Table or Carriage Ways

Another unique type of operation which has been adequately met by a highly refined oil is involved in the table or carriage ways. Here again, pressure circulation of a highly refined straight mineral oil is quite common, in the interest of causing these units to literally float on a film of oil.

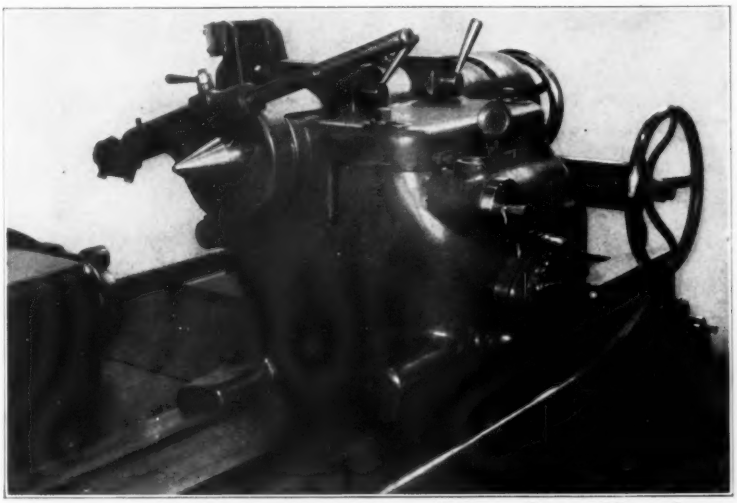
The inverted V-type way has been designed to eliminate, as far as possible, those inaccuracies which might develop due to wear of the ways. This is brought about by casting separately from the bed, by the use of special alloy iron distinctive for its wearing properties, and accumulating on the sliding surfaces.

Relation of Bearing Material to Lubrication

While the table ways as mentioned above are probably the most uniquely lubricated parts on the modern roll grinder, the grinding wheel spindle bearing is of interest from the viewpoint of its composition and finish. One manufacturer uses a special bronze alloy or steel-backed babbitt to form the sleeve bearing for the spindle. This latter, in turn, is of high-grade alloy steel, machined, heat-treated and ground to extreme accuracy. By reason of the

nature of the spindle surface, its bearing must be likewise prepared with the utmost care to permit of the necessary close clearance.

Surface finishes of this nature require most positive and constant circulation of lubricant in order to assure of full floating motion and minimum wear. The usual methods of adjustment to compensate for the latter have already been mentioned. So it is now fitting to study the method of lubrication. Usually this will involve an independent motor-driven pump mounted in an accessible position on the sub-base. This device delivers a constant and uniform flow of oil through the spindle-bearing clearance, from whence it passes to a reservoir for cooling and filtering prior to recirculation. By means of an electrical control, the action of this pump can be further controlled so that pre-lubrication of the spindle bearing can be developed before it takes up its load with the starting of the spindle. In this way, the most complete protection of both bearing and spindle surfaces is assured.



Courtesy of Norton Company

Fig. 10—Footstock of the Norton 36" roll grinder. On this unit the center, akin to the headstock, is grease gun lubricated. An auxiliary worm reduction to a hand wheel facilitates the making of delicate adjustments of the center to secure correct support of the roll. To further enable accurate service and easy movement a ball thrust bearing is mounted on the footstock screw.

OIL CHARACTERISTICS

Presence of any appreciable amount of water due to condensation may lead to formation of emulsions with certain types of oil. In a closed system, such as described above, where there is normally but little opportunity for the oil to rest and separate itself from water emulsions, oxidation may develop with subsequent sludge formation. All this will be aggravated should higher temperatures develop during pumping and circulation.

Sludge is a distinct detriment to lubrication, for it will tend to accumulate in clearance spaces, ports or other small apertures in the pump, to interfere with free flow and leakage of the oil past those parts which require lubricating films. Sludge accumulations in some oils may also be conducive to acidity, which may lead to corrosion of the spindle.

Low oxidizing and carbon-residue forming tendencies are also most important characteristics. They will normally be indicative of the durability of the oil and a guide to its resistance to breakdown.

By reason of the obvious necessity for an oil of high refinement, consideration of those tests which will be indicative of this will be of interest. These will include demulsibility, neutralization and carbon residue content. Viscosity, in turn, as already mentioned is indicative of the body and the pressure and temperature resisting ability, while the pour test becomes a factor in cold-starting conditions.

Emulsification and Demulsibility

There is a distinct relation between emulsification, or the rate at which an emulsion will develop when an oil is circulated or agitated in the presence of water, and demulsibility, or the rate at which this emulsion will subsequently precipitate itself or settle out. The extent to which it may become detrimental can be predicted by laboratory study of the demulsibility of the oil being used; normally it will depend upon the degree of refinement. For the more specific information of the operator, this means the extent to which the oil is a straight-run product or pure distillate, the care used in fractionating or segregation of distillates within a narrow range of viscosity, and the extent to which the finished products are subsequently filtered.

With certain types of heavier or more viscous oils, emulsified matter will settle out more slowly than from fluid products, or those of lower viscosity. This will be especially true where the same conditions of refinement have prevailed. The emulsifying tendency of certain oils will also be affected by oxidation. As a result, in a system which is not entirely free from air, continued circulation of oil in the presence of water at temperatures much above

150 degrees Fahr., may lead to more or less oxidation, which will materially increase the emulsifying and sludge-forming tendencies of the oil.

Acidity

The value of the Neutralization Number of an oil at any period of service, as an indication of corrosive acidity, is an open question. Extensive tests have shown that in some oils high organic acidity has apparently no serious effect upon their lubricating ability; other oils, in turn, only seem to require a slight increase in acidity to develop a very objectionable sludge-forming tendency. One must conclude, therefore, that it is a question more of the type of organic acidity rather than the actual amount which should be considered. In this regard, it is interesting to mention that authorities of the petroleum industry are giving this much study.

Carbon Residue

The test for carbon residue is of interest due to the degree to which it may be indicative of subsequent difficulties on account of carbon accumulations. This test was originally developed for the purpose of comparing the carbon-forming tendencies of various lubricating oils for internal combustion engine service. It has since been proved of value in connection with many other types of operation where temperatures may be reached which approximate the initial vaporization point of certain components of the oils being used. Its value in connection with equipment subjected to heavy duty and high pressures, which would tend to develop heat within the system, is, therefore, obvious, as an indication of the extent to which possible accumulation of residues in ports or small apertures might occur.

To appreciate the meaning of the "carbon residue" test, one must realize that petroleum lubricants are mixtures of a variety of hydrocarbon compounds which may differ widely in their physical and chemical properties. Some of these may vaporize even at atmospheric pressure and at comparatively low temperatures, leaving more or less of a non-volatile residue. Close fractionation and accurately controlled distillation will remove certain of these compounds in the course of refinement. Any free carbon which may be present in very finely divided state in the semi-finished oil can later be almost entirely removed by judicious filtration. The final product, if refined according to accepted practice in the handling of turbine and other high-grade oils, should show a very low carbon residue by either the Conradson or Ramsbottom Method of Test.

Lubrication of Car Wheel Bearings in Ceramic Operations

The art of moulding clay and later drying or firing the resultant shapes to form durable and useful articles of building or household ware dates back to antiquity. It was an art in which the ancients became especially proficient, as biblical accounts of the industry of the Israelites will testify. In those day brick-making was the principle forte of the potter, the bricks being made by mixing clay with chopped straw and sun-drying, to a hard and durable structure. Through succeeding ages from this crude origin the ceramic industry developed gradually through a series of transitions—always to greater and greater perfection, and the design of more intricate and useful articles.

As civilization progressed in the fashioning of clay products, demand, of course, increased. In other words, mass production became a factor. It was noteworthy in the records of the demand for bricks in the time of Charles the Second of England following the great fire of London, when so many of the buildings were constructed of wood. Natural stone could not satisfy the demand, so the brick came into its own.

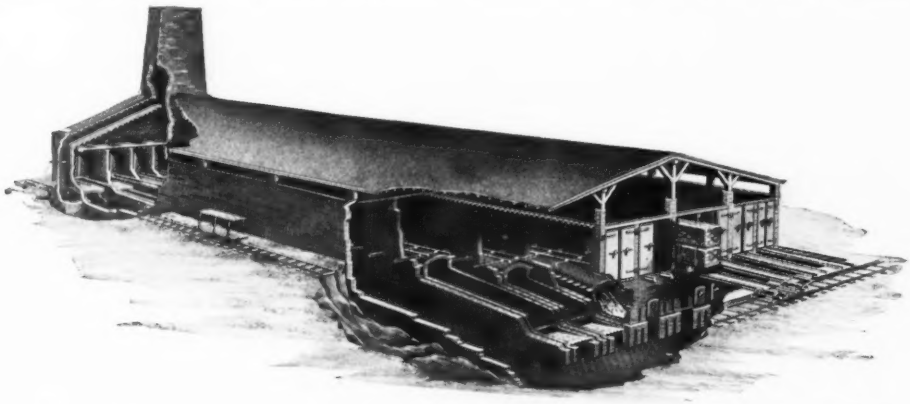
In those days of infantile mass production, one was confronted with a serious handicap, viz., the time element—for sun-drying, requiring a considerable period of time, predominated. Later the art of firing or burning was perfected, in the interest of producing a more uniform product in less time. Thus the kiln developed.

Kiln design has passed through much the same sort of transition—from the crude four-walled sunken pit, through the circular oven-type with spherical top, down to the modern continuous kiln of the twentieth century ceramic plant, which has proved such a factor in producing the art tile, chinaware, and plumbing fixtures for our home comforts.

The Tie-up with Petroleum

With the perfection of the continuous kiln the ceramic industry came to depend more and more upon the petroleum industry, for it was highly essential to effectively lubricate the wheel bearings of the kiln cars, which carried

the above mentioned products through the kiln. According to the nature of the clay being handled, its plasticity or relative moisture content and the intricacy of the pieces to be fired, these cars will have to be subjected to a temperature well above 300 degrees for several hours. Obviously, the effect of this slow heat will be the same on the bearing lubricant as upon the clay—viz., it will cause vaporization of the more volatile components, and baking of the residue. This is the primary reason for the usual difficulties in lubricating such equipment.



Courtesy of International Clay Machinery Co.

Fig. 11—Phantom view of a dryer, showing relative location of car tracks and provision for circulation of heat.

Kiln Design

To better understand how this may be brought about one must visualize the construction of the kiln as it is used today, and know of the degree to which its operation has been mechanized. Normally it is a long tunnel-shaped affair built of insulated firebrick to hold its heat, as this latter must be carefully regulated to enable subjection of the clay products to a gradually increasing temperature. Oil or gas for firing has largely superseded coal or wood as fuel.

To further facilitate this control of temperature and to enable bulk handling of the ceramic shapes with the least labor, they are stacked on flat cars which are run through the kiln over a narrow-gauge track laid along the floor. Building materials such as hollow tile, and bathroom fixtures are largely dried and fired in such kilns today.

The Process of Drying

The usual procedure after cutting or pressing the clay to the desired shapes, is to stack them onto drier cars for drying and hardening. The amount of drying which is necessary will depend on the service for which the ware is intended. Front or face brick, enamel brick and firebrick or other high temperature refractory shapes are subjected to additional pressing before drying. This is done on a special pressing machine which not only insures firm consolidation of the clay, but also squares up the edges and corners. Repress machines may be hand-operated, motor, or belt-driven, the bricks, etc., being fed to them either automatically or by hand, according to the facilities of the plant.

Drier cars, as the primary means of transportation in the plant, occupy an especially prominent position in the manufacture of brick and building tile, etc., the number used in the average plant generally amount to several hundred. A drier car is a relatively simple piece of apparatus, consisting chiefly of an iron frame-work mounted on wheels which run on narrow-gauge tracks.

Wheel bearings require very careful consideration from a lubrication viewpoint, due to the comparatively high temperatures under which the lubricant must function when the car is subjected to heat. For this reason anti-friction bearings as a refinement in construction have been given considerable study.

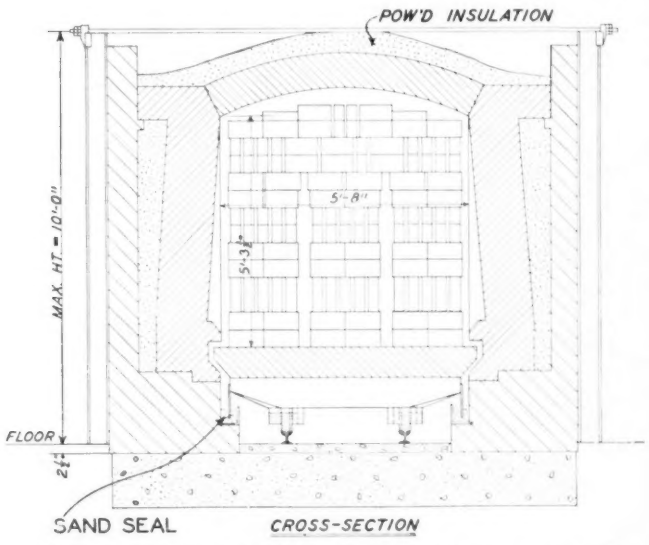
These cars serve to carry the various products to the drying rooms or tunnels and later to the kilns. When the drier cars are properly loaded they are rolled on industrial tracks to a heated dry room, where the contents are brought to practically complete dryness. The purpose of this is to insure against cracking or warping of the clay products when they are later subjected to the higher temperature of the kilns. In the soft mud and dry press processes the general procedure is the same as described above for the stiff mud process, with the exception of the shaping of the ware.

Drier Cars

In the lubrication of drier car-wheel bearings,

the problem, of course, is to meet high temperature conditions. Since the modern drier car wheel is usually equipped with roller bearings, it is primarily important to select a lubricant of such characteristics that it will resist the liquefying and carbonizing effects of heat. This becomes most aggravating when the cars must pass through continuous tunnel kilns because under the best conditions a certain amount of abnormal heat will reach the running gear regardless of the sand seals and insulated car construction which may be employed.

In average drier service, practice has indicated that a semi-solid high temperature grease is adaptable for the lubrication of these bearings. Ordinarily it should be a product containing a mineral oil constituent of relatively high viscosity, high flash point and low carbon residue content. By virtue of these characteristics, unless temperatures are distinctly abnormal, the lubricant should remain within the bearing in plastic condition for a considerable length of time. Use of such a product where test may prove it practicable should normally indicate greater economy than where an oil is employed, although first cost might be somewhat higher. The specific savings would show up in the labor item, due to reduction in the frequency of lubrication.



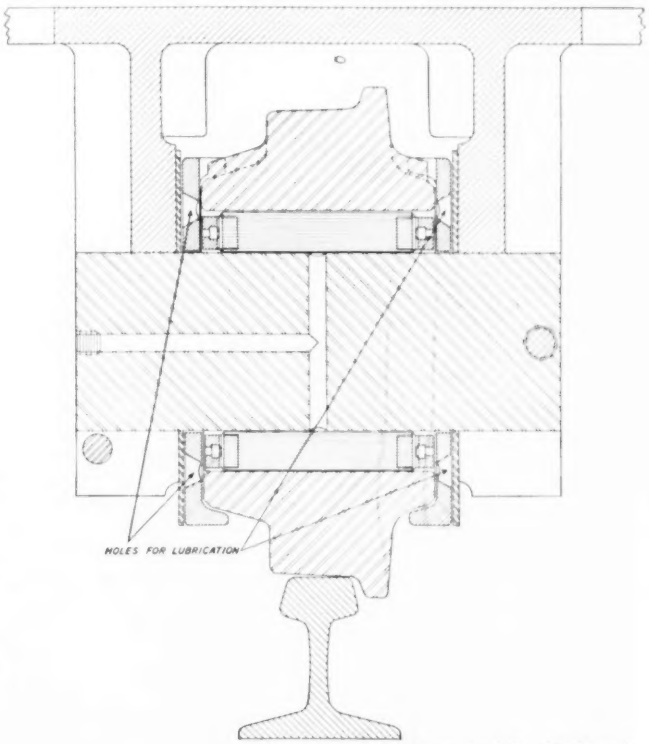
Courtesy of International Clay Machinery Co., and Harrop Ceramic Service Company.

Fig. 12—Sectional view of a Harrop Car Tunnel Kiln. Note in particular the groove in the side wall through which the insulated floor of the car passes in the interest of preventing direct passage of heat to the running gear of the car. Note also provision for the sand seal as an added means of preventing heat transmission.

Where drier car bearings are not given the proper attention from the viewpoint of lubrication they may frequently give trouble. The necessity for daily or trip lubrication, with subsequent neglect on the part of careless employees will generally be the reason for this. Such a lubrication procedure, however, will only be necessary when comparatively light oils are used.

Drying and Firing in the Pottery

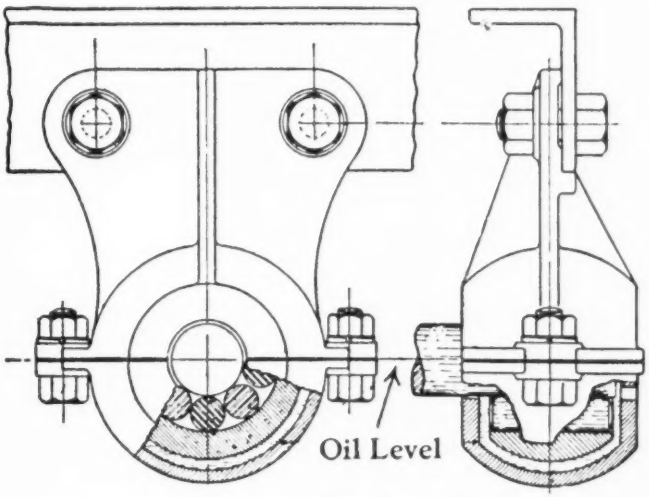
Pottery involves the manufacture of sanitary procelain, architectural tile and terra cotta. In this branch of the ceramic industry, after the clay has been pressed, cut, cast or moulded into the desired shapes, it must be dried until nearly bone dry, the length of time depending on the nature and size of the pieces. This involves treatment in waste heat or direct fired dryers at a temperature in the neighborhood of 200-250 degrees Fahr. After this they are



Courtesy of International Clay Machinery Co

Fig. 13—Sectional view of a kiln car wheel bearing. This design is unique by reason of the lubricating groove which is provided. This latter receives lubricant from the bore of the wheel delivering same through holes as indicated to lubricate the faces of the steel stationary washers and the cast iron cup washers.

fired to bring about complete contraction and hardening of the clay. This renders the finished products resistant to wear or discoloration.



Courtesy of International Clay Machinery Co.

Fig. 14—Structural details of a dryer car wheel roller bearing showing relative location of rollers to axle and race, also recommended oil level.

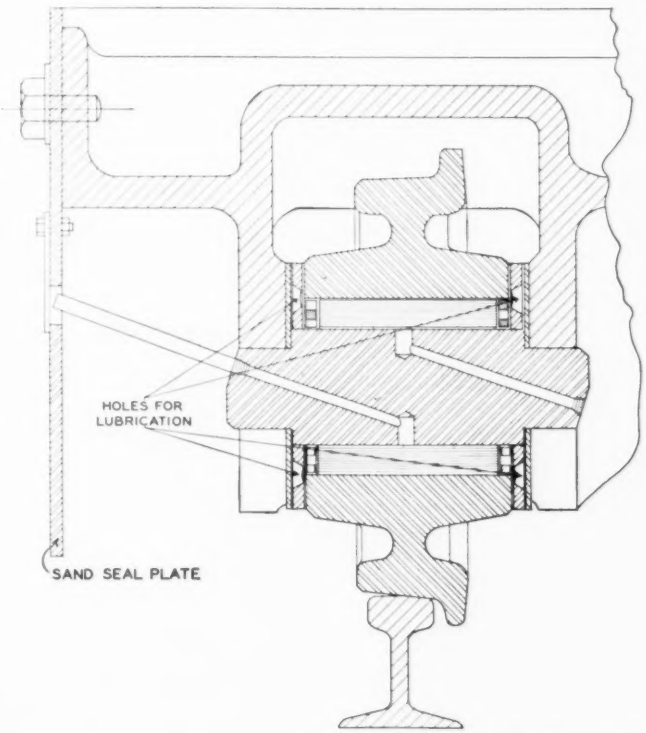
The nature of the firing process will depend upon the type of material being handled. Common brick, building tile, electric porcelain, and terra-cotta tile are single fired; the latter products being frequently glazed and fired in the green state, the glaze and body maturing at the same time. Wall and floor tile, chinaware, and sanitary porcelain, on the other hand, are double fired, first in the "biscuit" at high temperature, and then at a lower temperature after glazing.

Firing of clay products is one of the most important stages in their manufacture. Essentially the object is the same whether common brick or the most artistic of terra cotta is involved, viz., to burn the product to a permanent state of hardness. Depending upon the product, however, more or less care must be exercised in this process, not only in control of temperatures, but also in the time of treatment.

Where products such as enamelled brick, tile, and porcelain ware are concerned the possible discoloring effect of the gases of combustion upon the glazed surfaces must always be considered. Modern practice is to observe every effort to insure oxidizing conditions in the kiln. To this end some plants use kilns of the muffled type, the clay products being charged into the muffled heating chamber around which the gases of combustion circulate.

Larger pieces of porcelain ware, such as kitchen sinks, bath tubs, etc., can also be fired in a compartment type of gas fired kiln which does not require a muffle for the production of a very satisfactory glazed surface. Vitreous china such as tableware, small sanitary pieces, and architectural tile are either fired in muffled kilns or inserted in clay containers known as saggers, and then fired in direct contact with the heat.

In charging the kiln the saggers are either set one on top of the other where the smaller varieties of ware are to be fired or else the top sagger is inverted to enclose the protruding portion of the piece above the sides of the bottom sagger. In order to prevent the direct contact of the gases of combustion



Courtesy of International Clay Machinery Co.

Fig. 15—Another section of a kiln car wheel bearing showing not only the sand seal plate for prevention of heat transfer, but also holes provided for distribution of lubricant to the faces of the steel stationary washers and cast iron loose washers. Here again lubricant is applied as indicated through the bore of the wheel.

with the ware, the rim of each sagger is sealed to that of its neighbor by means of clay wads.

During the process of firing, the heat is regulated by observation of pyrometric test cones (termed Seger cones) inserted in the kiln. These are composed of various siliceous and mineral substances which give them varying melting points. Electric pyrometers are also used in some potteries. In addition, test samples of the same composition as the ware being fired, and frequently small rings of clay which change color at different temperatures are placed in the kiln, so as to be capable of withdrawal for observation of color and condition of glaze at normal room temperatures.

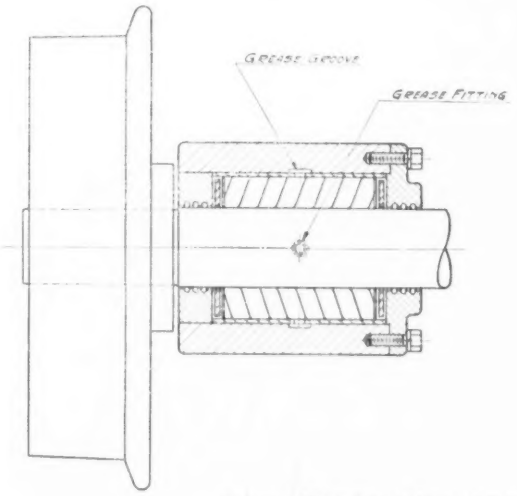
Kiln Car Bearings

In view of the comparatively high temperatures involved in kiln operations practical experience has dictated that the utmost care be given to the choice of the lubricant which is to be used on car-wheel bearings. In many cases kiln temperatures may range as high as 1800 degrees Fahr., or even above. This is no indication, however, that this will be the temperature of the car-wheel bearings, in view of the fact that water-cooling coils are, in many cases, placed in the base of the kiln on a level with the running gear of the cars. These latter are also oftentimes constructed with an insulated overhang or sand seal so as to prevent direct circulation of heat to the space below the car body.

There is, of course, a wide divergence of thought as to just what type of lubricant is best adapted for car-wheel bearings under such extreme temperature conditions. From a mechanical point of view, these bearings naturally have been improved over recent years, there having been a definite tendency to go to roller-type construction. It is obvious, however, that regardless of mechanical perfection, under the prevailing temperatures, it will be very difficult to obtain a lubricant of adequate stability to prevent some vaporization of the straight mineral component, and to preclude development of a certain amount of carbon residue. It is this latter, of course, which will accumulate within the bearings and ultimately prevent free motion of the rolling elements. For this reason some authorities have felt that a comparatively light viscosity straight mineral oil will give best results. The purpose, of course, is to use a lubricant which will develop as little carbon residue as possible within the bearings, the assumption being that an oil of this type will vaporize cleanly during the passage of the car through the kiln. Lubrication can meantime be assisted by the addition of a small amount of graphite to the oil prior to usage.

Others, in turn, prefer to use a heavier, more plastic type of lubricant on the order of a grease prepared from a low carbon-residue oil, a specially made soap and perhaps some lubricant assistant such as graphite. Regardless of the nature of the lubricant, the primary objective is to maintain lubrication for as long a period as possible with the development of the least amount of residue which might build up within the bearings and prevent free rolling as already stated.

Renewal of lubricant should be carried out when the wheel bearings are as cool as possible. Some authorities suggest this after the cars are loaded and just before they enter the kiln. The manner of lubrication will, of course, depend on the nature of the lubricant. Where the latter consists chiefly of a light, straight mineral oil, the hand oil can is often best adapted. With more viscous products, however, a grease gun may be preferable. To accomplish best results, as little lubricant as possible should be used, for, obviously, if an excess is charged it will cause just that much more carbon residue and meanwhile will give no assurance of better lubrication.



Courtesy of Roller Bearing Co. of America

Fig. 16.—Showing the application of the RBC type of flexible roller bearings to kiln car wheel operation. Note point for application of lubricant and groove for distribution. Note also sealing grooves at each end of the housing.

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